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ARTICLE XV.

OBSERVATIONS OF THE MAGNETIC DIP IN THE UNITED STATES.

BY PROF. ELIAS LOOMIS.

IN the Transactions of the American Philosophical Society, Vol. VII., pages 1—6, and pages 101—111; also, Vol. VIII., pages 65—72, and pages 285—304, I have given numerous observations on the Dips of the Magnetic Needle, made by myself, in different parts of the United States. The following observations were made with the same instrument heretofore employed. This instrument was made by Gambey, of Paris, and has two needles. In 1841, the axis of one of the needles appears to have sustained some injury, and since that time the needle has been entirely discarded, and all the observations have been made with the other needle. The mode of observation is the same as has been described in Vol. VII., page 3, of the Transactions of the American Philosophical Society.

Magnetic Dips at Hudson, Ohio, Lat. 41° 15′, Long. 81° 25′ West.

Place of observation, magnetic station formerly used.

DATE.	HOUR.	POLARITY.	NO. READINGS.	DIPS.	
1842, May 17.	9—10 A. M.	Mark down.	40	72°	45.′2.
“ “	“	Mark up.	40		53.3.
“ “	“	Mean result.	80		49.3.
“ “	10—11 A. M.	Mark up.	40		53.0.
“ “	“	Mark down.	40		47.8.
“ “	“	Mean result.	80		50.4.
		Mean of both sets of obser.	160	72	49.9.
1842, Aug. 23.	9—10 A. M.	Mark down.	40	72	46.7.
“ “	“	Mark up.	40		51.4.
“ “	“	Mean result.	80		49.1.

DATE.	HOUR.	POLARITY.	NO. READINGS.	DIP.	
1842, Aug. 30.	10—11 A. M.	Mark down.	40	72	46.9.
" "	"	Mark up.	40		46.9.
" "	"	Mean result.	80		46.9.
1842, Sep. 14.	3—6 P. M.	Mark down.	40		41.6.
" "	"	Mark up.	40		46.5.
" "	"	Mean result.	80		44.0.
		Mean of three sets of obser.	240	72	46.7.
1843, June 26.	2—5 P. M.	Mark up.	40	72	46.0.
" "	"	Mark down.	40		48.4.
" "	"	Mean result.	80		47.2.
1843, Sep. 18.	7½—9½ A. M.	Mark down.	40	72	45.1.
" "	"	Mark up.	40		50.3.
" "	"	Mean result.	80		47.7.
1844, June 22.	7—8 A. M.	Mark up.	40	72	47.6.
" "	"	Mark down.	40		51.8.
" "	"	Mean result.	80		49.7.
1849, July 18.	3—5 P. M.	Mark down.	40	72	55.5.
" "	"	Mark up.	40		53.3.
" "	"	Mean result.	80		55.4.
1849, July 27.	7—9 A. M.	Mark up.	40	72	54.7.
" "	"	Mark down.	40		56.2.
" "	"	Mean result.	80		55.5.
1849, July 27.	9—11 A. M.	Mark down.	40		55.5.
" "	"	Mark up.	40		54.8.
" "	"	Mean result.	80		55.2.
		Mean of obser. in 1849.	260	72	55.4.
1859, April 2.	10½—12 A. M.	Mark up.	40	72	65.6.
" "	"	Mark down.	40		58.9.
" "	"	Mean result.	80	73	2.3.

The following Table presents a summary of all the observations made at Hudson, Ohio, the numbers here given indicating the mean of all the observations of the year:—

DATE.	DIPS.
1838—68.	72° 48.2′.
1839—46.	47.6.
1840—35.	49.5.
1841—60.	48.1.
1842—52.	48.3.
1843—59.	47.5.
1844—47.	49.7.
1849—56.	55.4.
1859—25.	62.3.

These observations indicate, that at Hudson, Ohio, the Dips of the Magnetic Needle remained sensibly stationary from 1838 to 1844; and, that since the latter date, the Dip has slightly increased.

In order to determine whether the instrument had sustained any injury, I requested Prof. C. A. Young, of Western Reserve College, to make a series of observations similar to those which I have published in the Transactions of the American Philosophical Society, Vol. VIII., page 66. This he accordingly did, and the following are his results. The observations were made from April 19th to May 2d, 1859, and each number in the two columns headed "Poles Direct," "Poles Round," is the mean of twenty readings, making a total of 1360 readings, besides a double set of readings for azimuths and 180 degrees.

Magnetic Dips observed at Hudson, Ohio, by Prof. C. A. Young.

Azimuth.	Poles Direct.		Poles Round.		Mean.		Dips Deduced.	
	°	′	°	′	°	′	°	′
0	72	59.4	72	52.0	73	2.1	73	2.1
180	73	11.3	73	5.8				
10	73	16.0	73	1.6	73	15.0	72	59.7
190	73	22.8	73	19.5				
100	87	7.5	86	57.4	86	53.6		
280	86	41.5	86	47.9				
20	74	6.7	78	38.5	73	59.9	73	6.0
200	74	10.5	74	3.8				
110	84	25.4	84	28.9	84	16.2		
290	84	7.7	84	2.7				
30	75	19.5	74	38.0	75	7.8	72	57.7
210	75	17.7	75	15.9				
120	81	35.7	81	38.1	81	18.0		
300	81	1.3	80	56.6				
40	76	46.5	76	36.7	76	44.3	72	45.5
220	76	38.5	76	55.3				
130	78	42.9	78	55.5	78	35.2		
310	78	7.9	78	34.3				
50	77	59.5	78	33.7	78	33.3	72	45.7
230	78	41.1	78	58.6				
140	76	39.5	76	57.6	76	46.2		
320	76	48.3	76	39.2				
60	80	50.3	81	1.1	81	13.9	72	52.0
240	81	29.2	81	35.0				
150	75	13.8	75	17.6	75	3.3		
330	75	3.7	74	38.1				
70	84	3.5	84	1.0	84	12.3	73	4·0
250	84	15.0	84	29.9				
160	74	6.5	74	4.3	73	59.1		
340	74	8.4	73	37.1				
80	86	33.6	86	44.2	86	52.3	73	1.1
260	87	21.1	86	59.4				
170	73	31.9	73	18.6	73	16.6		
350	73	12.5	73	3.1				
General Mean.							72	57′1

As these observations did not agree as well as was expected, a second series of observations was undertaken. The whole number of readings in the second series was 2880, (being ten of each end of the needle in every position,) besides some 500 or 600 more in the re-examination of all readings that seemed either too discordant with the former results or suspicious in themselves. The observations were all taken between the hours 7½ and 10 A. M., and the readings for the azimuth 60, 70 and 80 degrees, were all made between the hours 8½ and 9½ A. M.

The following is the summary of the second series of observations made between May 4th and June 30th, 1859.

Magnetic Dips observed at Hudson, Ohio, by Prof. C. A. Young.

Observations Repeated.

Azimuth.	Poles direct.	Poles round.	Mean.	Dip deduced.	Azimuth.	Poles direct.	Poles round.	Mean.	Dip deduced.
	° ′	° ′	° ′	° ′		° ′	° ′	° ′	° ′
0	73 1.9	72 52.4	73 2.7	73 2.7	50	77 59.8	78 36.5	78 33.4	72 45.8
180	73 10.4	73 6.2			230	78 39.3	78 58.2		
10	73 14.9	73 5.5	73 16.5	73 1.3	140	76 42.0	76 56.0	76 46.2	
190	73 25.5	73 20.2			320	76 51.4	76 35.2		
100	87 7.2	87 0.7	86 54.1		60	80 55.2	81 3.3	81 16.4	72 58.1
280	86 43.0	86 45.6			240	81 31.4	81 35.7		
20	74 10.1	73 39.7	74 1.3	73 7.7	150	75 19.3	75 17.2	75 9.1	
200	74 14.0	74 1.5			330	75 23.4	74 36.5		
110	84 25.6	84 30.0	84 17.3		70	84 7.2	84 0.3	84 13.8	73 6.5
290	84 8.8	84 4.8			250	84 20.9	84 26.6		
30	75 22.7	74 33.5	75 5.5	72 56.9	160	74 13.6	74 2.7	74 1.3	
210	75 13.8	75 11.8			340	74 8.5	73 40.1		
120	81 35.6	81 40.5	81 20.5		80	86 42.0	86 44.0	86 52.7	73 0.6
300	81 0.8	81 5.2			260	87 8.6	86 59.2		
40	76 52.4	76 35.2	76 45.5	72 47.5	170	73 27.2	73 17.9	73 16.1	
220	76 40.5	76 54.1			350	73 13.5	73 5.8		
130	78 40.8	79 0.2	78 36.9						
310	78 7 5	78 36.9					General mean.		72° 58′.6

These observations agree very well with the first series, but the results harmonize very little better with each other. If we deduct the Dip by the formula $\cot \delta = \cot I \sec a$, we shall obtain the following results:

	First Series.		Second Series.	
Azimuth.	Inclination.	Dip.	Inclination.	Dip.
	° ′	° ′	° ′	° ′
0	73 2.1	73 2.1	73 2.7	73 2.7
10	73 15.8	73 1.2	73 16.3	73 1.7
20	73 59.5	73 1.3	74 1.3	73 3.2
30	75 5.6	72 54.8	75 7.3	72 56.7
40	76 45.2	72 55.1	76 45.9	72 55.9
50	78 34.2	72 32.4	78 35.1	72 33.7
60	81 15.9	72 55.4	81 18.5	72 59.9
70	84 14.2	73 33.7	84 15.5	73 37.1
80	86 52.9	72 34.8	86 53.6	72 37.7
Mean Dip.		72 56.7	Mean Dip.	72 58.8

From the preceding results, it is pretty evident that the instrument with which the observations were made, has sustained some injury since 1844, and this injury is probably in the axis of the needle. The axis is apparently free from rust, and no imperfection can be detected by ordinary inspection, but a very slight flexure of the axis, or the smallest want of cylindricity, would produce discrepancies such as are here exhibited. I think, however, that these observations are sufficient to furnish the Dip with an uncertainty not exceeding five minutes. If we take a mean of all the observations without distinction, we obtain for a result 72° 57′.8. If we reject the readings which differ most from the mean, we obtain for a result 72° 58′.6. The latter result is, I think, to be preferred; but either result indicates that the Dip of the needle at Hudson has increased since 1844.

The following are a few additional observations made by myself in the vicinity of Hudson:

Tallmadge, Lat. 41° 7′, Long. 81° 25′ West, near the coal mine.

Date.	Hour.	Polarity.	No. Readings.	Dip.
1842, Sept. 3.	11—12 M.	Mark up.	40	72° 54.′0
“ “	“	Mark down.	40	51.1
“ “	“	Mean result.	80	5.25

North Akron, Lat. 41° 5′, Long. 81° 30′ West, a quarter of a mile east of the village.

1842, Sept. 5.	2—3 P. M.	Mark down.	40	72 48.1
“ “	“	Mark up.	40	56.4
“ “	“	Mean result.	80	52.2

Cuyahoga Falls, Lat. 41° 9′, Long. 81° 27′ West, a quarter of a mile south-east of the village.

1842, Sept. 6,	10—11 A. M.	Mark up.	40	72 52.1
“ “	“	Mark down.	40	49.6
“ “	“	Mean result.	80	50.9
“ “	11—12 M.	Mark down.	40	50.3
“ “	“	Mark up.	40	54.5
“ “	“	Mean result.	80	52.4
“ “	Mean of both series of observations.		160	72 51.6

Franklin, Lat. 41° 11′, Long. 81° 20′ West.

1842, Sept. 8,	4—5 P. M.	Mark up.	40	72 55.4
“ “	“	Mark down.	40	51.2
“ “	“	Mean result.	80	53.3

Rootstown, Lat. 41° 7′, Long. 81° 14′ West.

1842, Sept. 9,	1—2 P. M.	Mark down.	40	72 51.3
“ “	“	Mark up.	40	68.2
“ “	“	Mean result.	80	59.7

Paris, Lat. 41° 11′, Long. 81° 2′ West, near the village.

DATE.	HOUR.	POLARITY.	NO. READINGS.	DIP.
1842, Sept. 10,	6—7 A. M.	Mark up.	40	73 11.0
" "	"	Mark down.	40	72 54.0
" "	"	Mean result.	80	73 2.5

The following observations were made by myself with an instrument kindly loaned for this purpose by Prof. Bache, Superintendent of the United States Coast Survey. The place of observation was in the middle of the grove behind the Lunatic Asylum at Bloomingdale, about seven miles north of the City Hall of New York.

Bloomingdale, Lat. 40° 49′, Long. 73° 57′ West.

1859, June 11,	10½ A. M.—3 P. M.	Needle No. 1.	40	72 45.5
" "	"	Do. poles round.	40	60.2
" "	"	Mean of No. 1.	80	52.9
" "	"	Needle No. 2.	40	44.8
" "	"	Do. poles round.	40	56.5
" "	"	Mean of No. 2.	80	50.7
" "	"	Needle No. 3.	40	36.3
" "	"	Do. poles round.	40	59.5
" "	"	Mean of No. 3.	80	47.9
" "	"	Mean of three needles.	240	72 50.5

These observations, compared with those heretofore made in this vicinity, indicate that the Dip of the needle at New York was decreasing from 1823 to 1846, since which time it has slightly increased. These results correspond tolerably well with those obtained at Hudson, Ohio, both as respects the time and amount of the change of Dip.